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RECLAMATION era

A WATER REVIEW QUARTERLY

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RECLAMATION era

Kathleen Wood Loveless, Editor

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COVER. Early morning sun and a slight ground fog join to make an eerie and yet beautiful scene on Jackson Lake. See article on page 11.

United States Department of the Interior
Rogers C. B. Morton, Secretary

Bureau of Reclamation, Ellis L. Armstrong
Commissioner

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COMMISSIONER'S PAGE

A HOPEFUL NEW YEAR

The New Year greeted us with open arms and challenges aplenty. 1972 will be a record year for opportunities and accomplishment.

Congress has supplied funds for the largest dollar program this fiscal year that the Bureau of Reclamation has ever undertaken, and the administration has approved a budget request for an even more active program in fiscal year 1973.

But while these facts are gratifying, our emphasis is not on dollars available but on programs completed, on accomplishments, and on the benefits that will accrue therefrom.

If Congress grants requested funds, we will be undertaking the Oahe project in South Dakota. This project is a companion to the Garrison diversion project in North Dakota. Both will enable the respective States to make greater use of the waters of the Missouri River for the enrichment of the economy in an area where population has dwindled for lack of opportunity.

It will be possible to start active construction on the central Arizona project for which the people of that State have fought and bled for many decades. And work will proceed on many other authorized projects which are equally critical to the areas in which they are located.

The expedited program will permit construction work to proceed at a more orderly and economical rate that will bring immediate job benefits in some areas which are hard hit by unemployment. While these benefits are good, they will be overshadowed by the returns which will accrue from millions of kilowatts of nonpolluting hydroenergy being installed at Grand Coulee Dam, for example, or the millions of gallons of water which will be supplied to cities, industries, and farms throughout the arid West from these projects.

Water is literally life and prosperity in the Western States and the Reclamation program now underway will widen the margin between that prosperity and the disaster which comes when the water supply is exhausted.

ELLIS L. ARMSTRONG
Commissioner of Reclamation

London Bridge is up

by EUGENE E. HERTZOG, Chief Photographer
Boulder City, Nev.

FOR millions of Americans who learned the nursery rhyme "London Bridge Is Falling Down" during their childhood, the bridge is a living legend.

It has not "fallen down" but was taken down, stone by stone, and reconstructed at Lake Havasu City, Ariz., crossing a scenic mile-long waterway, now part of Lake Havasu. Forty-five-mile-long Lake Havasu is backed up by the Bureau of Reclamation-built Parker Dam on the lower Colorado River. It is one of several Bureau of Reclamation structures which have brought the Colorado under control and made useful as a servant man.

London Bridge was sold because it could no longer accommodate London's mounting traffic and has been replaced by a new bridge. The bridge was purchased from the Corporation of London in 1968 by the McCulloch Oil Corp. for $2,460,000 in competitive bidding.

Lively Bidding

Bidding was wild and exciting in April of 1968. The story goes that there were at least two bidders willing to pay $2,400,000 for the bridge, but on a hunch, Robert P. McCulloch added another $60,000. When asked why $60,000, he said he figured he'd be 60 years old by the time he had it where he wanted it—on the land bought along the

Famous London Bridge spanning Lake Havasu drew a crowd estimated at 16,000 during the dedication ceremonies at the bridge opening.

Lights on the bridge reflect upon Lake Havasu while gay festivities are in progress under the candy-striped tent.

lower Colorado River for a planned city he believed would eventually have a population of 75,000, hence 60 was a good number.

Whether or not the story is true, the bridge was sold to McCulloch for $2,460,000, who had it dismantled stone by stone and transported 10,000 miles from the River Thames, which it had spanned since 1831, to Lake Havasu City.

The 22,000,000 pounds of stone, each code-numbered, were shipped through the Panama Canal, unloaded at California ports, then trucked several hundred miles across the Mojave Desert.

The world's largest jigsaw puzzle was then reassembled over a period of 23 months. By the labor of only 40 men using modern machinery and methods, this task showed quite an improvement over the same job in the 19th century when it took 800 laborers 8 years to complete.

The Royal Ceremony

The foundation stone of the bridge was ceremoniously placed at Lake Havasu City by Sir Gilbert Inglefield, 685th Lord Mayor of London, on September 23, 1968. And on October 10, 1971, London Bridge was opened to the tune of blowing trumpets by Sir Peter Malden Studd, 688th Lord Mayor of London, and Governor Jack Williams of Arizona.

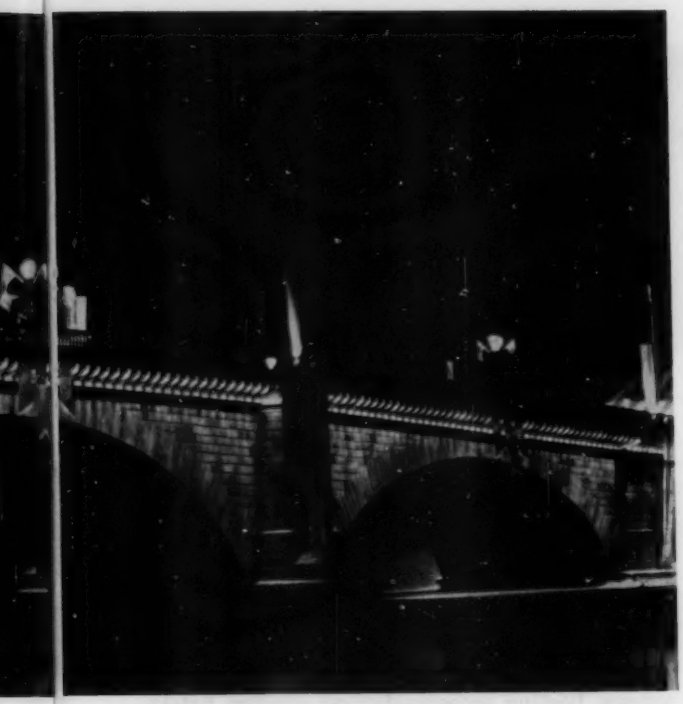
The fanfare surrounding the bridge's reopening rivaled the splendor of the opening festivities King William IV held to celebrate the bridge's London opening on August 1, 1831.

Even though the main course of the opening banquet—lobster and roast beef—was the same, the logistics of serving the meal would have placed the King in a quandry. In 1971, the complete dinner and all that went with it—vegetables, salad, soup, dessert, wine; bone china, glassware, cutlery; cooks, waitresses, etc.—were trucked 300 miles from Los Angeles.

The dinner for 800 held under a candy-striped tent, was a showroom of 19th century costumes in fantastic colors. Beneath the chandeliers of the tent, Sir Peter Studd, wearing the ancient ceremonial clothing and trappings of his office, greeted guests who had come to see this large antique erected.

Construction of the Bridge

The rebuilt bridge is much stronger than the structure in London, despite weighing only about



one-quarter as much and taking only about one-fourth the time to build. Provisions for expansion and contraction of as much as 6 inches were made. All piers rest on Rotoflon bearings built into the pier footings.

The steel-reinforced concrete superstructure of the brige was completed in October 1970 by M. M. Sundt Construction Co. of Tucson, Ariz., under a $1.6 million contract with McCulloch Properties, Inc. Affixing of London Bridge's granite stones to the superstructure was completed late in the summer of 1971.

Construction of the mile-long waterway that flows beneath the arches of London Bridge, required removal, through combined excavation and dredging operations, of more than 2,500,000 cubic yards of earth. The waterway is approximately 150 feet wide at each end, 750 feet across at the bridge site and ranges in depth from 10 to 15 feet.

The $1.6 million English Village complex, planned by C. V. Wood, Jr., designer of Disney-

Lord Mayor of London, Sir Peter M. Studd, presents the First Place Family Award in the Elizabethan Dress Contest.

The 19th century English Village created on the riverbank adjacent to the London Bridge is complete with shops, restaurants, and pubs.

land, occupies 3 acres and is the first phase of an international resort complex adjacent to the north end of the bridge on the mainland.

Site Six

Lake Havasu City has come a long way since World War I when it was "Site Six," named and used by the Army as a semi-secret camp to rehabilitate Air Corps pilots suffering from combat fatigue and psychoses.

From Site Six, it developed into a remote fishing camp; so secluded was the camp that only 4-wheel drive vehicles could get there by driving south from Topock. But in the short span of 7 years, Lake Havasu City burgeoned to a population of more than 8,000.

The vigorously growing community has earned recognition as a prototype for new cities of the future, cities that will be needed to meet the demands of America's predicted population growth.

Lake Havasu City has turned a 26-square-mile stretch of barren but beautiful lakefront land into a year-round resort with sandy beaches, green golf courses, boating accommodations, modern hotels, well-kept campgrounds, an airport, and more than 400 businesses and professional enterprises. Now to top it off—it is the new home of historic London Bridge. # # #

WATER Quiz

1. In what two areas of the world did irrigated agriculture first begin in 3500 B.C.?

2. What property of DDT causes it to remain in lakes and streams over a period of years?
   a. The buoyant nature of the compound.
   b. Its resistance to breakdown by microorganisms.
   c. The solid/compact structure of each molecule.

3. What is a *chinampa* system? Where did it originate?
   a. A drainage system. a. Denver, Colo.
   b. A crop rotation system. b. Canada.
   c. Another name for trickle irrigation. c. Mexico.

4. Large quantities of water are needed to complete the food chain. Approximately how much water is needed to make 1 pound of beefsteak from the start of the cycle when water falls on the plant leaves to the time the beefsteak is made?
   a. 1,000 gallons of water.
   b. 2,500 gallons of water.
   c. 1,300 gallons of water.

5. What occurs when cloud seeding causes rain?

Answers on page 23.

Reservoir Destratification Improves Water Quality

by Reginald G. Howard, Supervisor
Water and Land Operations, Region 2
Sacramento, Calif.

CASITAS Municipal Water District in California has made substantial progress with a new line of attack in meeting water quality problems. Operators are injecting compressed air into Casitas Lake to equalize temperature and dissolve oxygen content. The air is injected about 140 feet from the surface and creates currents, which seem to "stir" the water throughout the reservoir.

The results to the user are cooler water, reduced tastes and odors, reduced organic content, much better chemical quality, reduced costs for quality control, less use of chlorine, and reduced treatment costs to some industries.

A side benefit is the improved fishery in the lake.

The District started experimenting with air injection 4 years ago to eliminate problems caused by high summer temperature of surface waters.

Prior to that time algae growth, spurred by warm surface water and high concentrations of nutrients at the surface, caused taste and odor problems. Users complained.

Treatment to control the algae consisted of copper sulphate and citric acid, applied to the shallower water at a cost of some $20,000 a year.

The theory of injecting air into a lake was not completely new. Others have done it on a smaller scale. It was the first time, however, that a body of water as large as Lake Casitas had been treated successfully.

Casitas Lake is a reservoir built by the U.S. Bureau of Reclamation about 10 miles from Ventura, Calif. When full it covers 2,700 acres, contains 250,000 acre-feet of water and at a maximum is 270 feet deep.

Water service is furnished to agriculture (mostly truck and citrus crops), and municipalities and industry. The latter has increased rapidly as the area has experienced a large influx of industrial development and residential subdivisions. As municipal and industrial uses increase, water quality control becomes more and more important.

Algae growth that causes taste and odor problems is a constant problem in reservoirs, especially in warmer climates.

In summer the lakes stratify; that is, a layer of warmer water forms on top with colder water below. The natural dissolved oxygen is concentrated in the warmer surface waters.

Warm temperatures together with sunlight and high nutrient content encourage algae growth. When the algae begins to die, the resultant taste and odor are objectionable.

Others had discovered that air bubbling to the surface, after being piped to the bottom of the reservoir, creates currents that tend to equalize both water temperature and oxygen content. Accordingly, in 1968 the district started experimenting with air injection.

The operators had many problems. They had to learn about equipment, how to regulate depth and air pressures, and how much air to inject.

They learned by doing. They found, for instance, that air injected at the very bottom created more problems than it cured, by bringing manganese into solution from the bottom sediments.

Water containing appreciable quantities of manganese is undesirable for domestic use because it causes staining of porcelain and laundry.

The air injection system now being used consists of two 315-cubit-foot-per-minute electrically driven compressors. Both are operated continuously from March until October except when one is down for maintenance or servicing.

Air is carried through a 3-inch pipe supported on barrel floats to the deepest part of the lake. Here, four 1-inch hoses lead down to a diffuser system 140 feet below the surface. Air bubbling up from diffuser system makes the lake "boil" over

a 2- or 3-acre area.

Contrary to what one might think, the effects of this "boil" of water are not confined to the one site. Imperceptible currents are set into motion that seem to reach and affect every part of the lake. Samples show that the summer surface temperatures are some 2 to 3 degrees below pre-treatment, and deeper temperatures are somewhat higher than before.

Dissolved oxygen is found to depths of 120 feet throughout the summer, as compared to only 25 feet prior to aeration.

Costwise, the air injection is less expensive than previous treatments of algae with copper sulphate. After a capital outlay of $19,000, operation and maintenance costs are projected at about $12,000 a year.

Surface treatment by copper sulphate, which cost approximately $20,000 per year prior to aeration was not necessary during the past year.

Due to improved quality of the water, much less chlorine is required for efficient treatment.

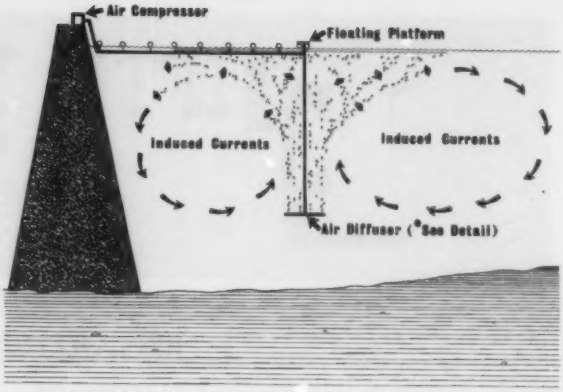
The benefits extend beyond cash costs to the district. One industry had spent about $250 a day for chemicals to *remove* oxygen from the water. Now, cost has been reduced considerably because water with a much lower dissolved oxygen content is selected for use.

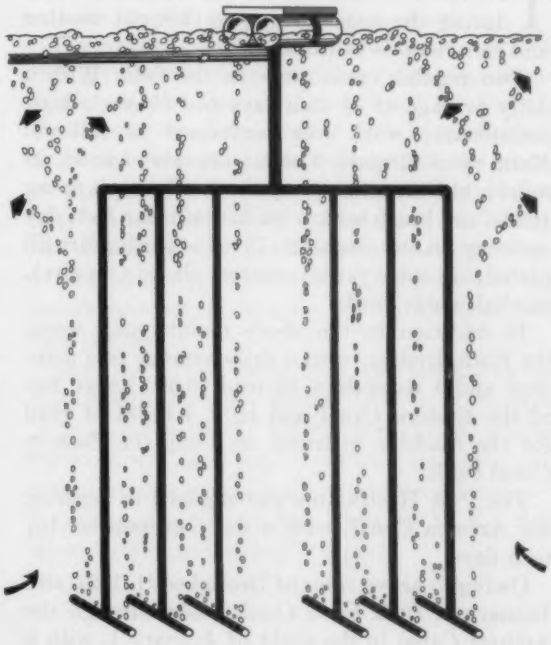
Fishing has been improved. The lake is a favorite spot for campers and fresh water fishermen from the Los Angeles metropolitan area, and 100,000 catchable trout are planted in the lake each year. Since the air injection program began, these fish have thrived.

Trout have shown remarkable growth. Many trout planted as ¼-pound fish now weigh 5 pounds or more.

Whether this system developed by the Casitas District will solve similar problems elsewhere will have to be determined. Obviously, no two situations are exactly alike, nor can their solutions be exactly the same. The success of the Casitas District, however, points to a method that fully merits consideration by others with similar problems.

# # #





***DETAIL OF AIR DIFFUSERS**

Casitas Reservoir Aeration System—Two 315-cubic-foot-per-minute compressors supply air to the system through a 3-inch pipe suspended near the water surface from 55-gallon drums. The air diffuser system is suspended from an 8- by 8-foot platform, plus additional drums not shown in the drawings. The diffuser is made up of 1-inch pipes, 140 feet in length, spaced at 25-foot intervals. The induced currents produced by rising air bubbles are sufficient to "mix" virtually all the water stored in the 240,000-acre-foot reservoir. Care must be used to avoid placing the diffuser too close to the reservoir bottom, possibly disturbing accumulated sediment. In this case, air was released about 70 feet above the bottom.

FIFTY YEARS AGO
in Our Magazine

RECLAMATION RECORD—1922

SALT RIVER PROJECT, ARIZONA

THERE was little demand for irrigation water during the month owing to the cold weather and considerable rainfall.

Two regular crews were in the field. With a daily average of 74 man-days and 32 stock-days, maintenance work was performed as follows: Main canal cleaned, 1 mile; laterals cleaned, 29 miles; old structures repaired, 30; riprapping (stake and brush banks) built, 311 linear feet; dry masonry placed (repairs), 78 cubic yards; dirt fill placed, 570 cubic yards; concrete placed (repairs), one-half cubic yard.

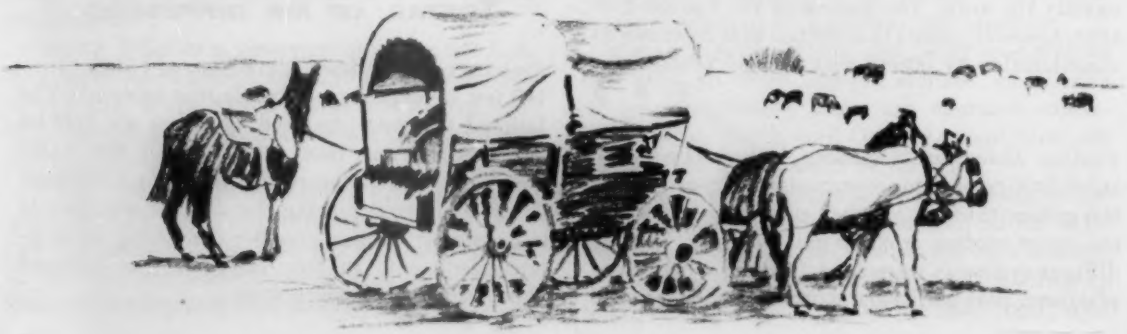
In addition to the above maintenance work, the Ruth dredger, with a daily average of 4 man-days and 4 stock-days, bermed 26,900 linear feet of the Eastern Canal and built 4 miles of road for the machine to travel on along the Eastern Canal bank.

The P. & H. dragline was engaged in berming the Arizona Canal, with a daily average of 1¾ man-days.

Owing to heavy rains of December 31, 1921, and January 1, 1922, Cave Creek broke through the Arizona Canal in the night of January 1, with a flood of approximately 12,000 second-feet. Work was immediately started on making repairs with a crew of 57 men and 64 head of stock; 4,940 cubic yards of sand were removed from the Arizona Canal and 410 cubic yards of dirt fill was made in the Grand Canal. All work was completed within a period of 12 days and water was again running in the Arizona and Grand Canals on January 13, 1922.

The following construction work was achieved during the month, with a daily average of 36 men and 11 stock: Concrete placed, 21½ cubic yards; dry masonry placed, 5 cubic yards; excavation (dirt) made, 615 cubic yards; fill (dirt) made, 102 cubic yards; concrete pipe installed, 468 linear feet; corrugated iron pipe installed, 275 linear feet; redwood headwalls for culverts built, 16; concrete headwalls for culverts built, three new pump laterals built, 3½ miles; 9 by 16 feet standard throw-down bridges built, eight; new well sites fenced, three; mile fence moved, one-fourth mile; redwood turnout installed, one; sand and gravel hauled, 18 cubic yards.

Work was continued on widening the Eastern Canal. The Monighan 2-yard dragline and the Lidgerwood 1½-yard dragline excavated 8,870 cubic yards during the month.



today...

SINCE construction of the Navajo Generating Station began in December 1969, the goals of its operators have been to meet the power demands of the West and to do so in a manner which will protect the environmental qualities of the area.

The Bureau of Reclamation is a participant because 25 percent of the output will be used for pumping power for the Central Arizona project and because water for the generating station will be supplied from Lake Powell.

Today the $755 million Navajo Power project seeks this goal by allocating $140 million of the $755 million for environmental protection.

The generating station, now under construction, is a 2,310,000-kilowatt coal-fired steam powerplant about 4 miles east of Page, Ariz.

It is being designed to remove 99.5 percent of particulates in the flue gases. Emissions from the station will meet or be less than established limits under Arizona's strict pollution law.

Sulphur oxide removal equipment will also be installed in the station. This is the first large station to have sulphur oxide removal devices. Coal from the Navajo and Hopi Indian Reservations has a lower sulphur content than average. Water pollution will not be a factor, since all cooling water is being recycled and none will be returned to Lake Powell and the Colorado River.

The Navajo powerplant is owned and operated by 5 private and public utilities serving southern California, Nevada, and Arizona and the Bureau of Reclamation. They are the Salt River Project which is constructing, and will operate the plant, the Arizona Public Service Co., the City of Los Angeles, the Nevada Power Co., and the Tucson Gas & Electric Co. The Federal Government has purchased 24.3 percent—561,000 kilowatts—of the plant's generating capacity for the Central Arizona project.

Over the life of the project, the benefits to the Navajo and the Hopi Indian tribes are estimated to be in excess of $70 million from leases, grants, rights-of-way, and coal royalties, plus other economic benefits such as employment preference.

Quite some change has occurred on the Salt River project in the last 50 years!

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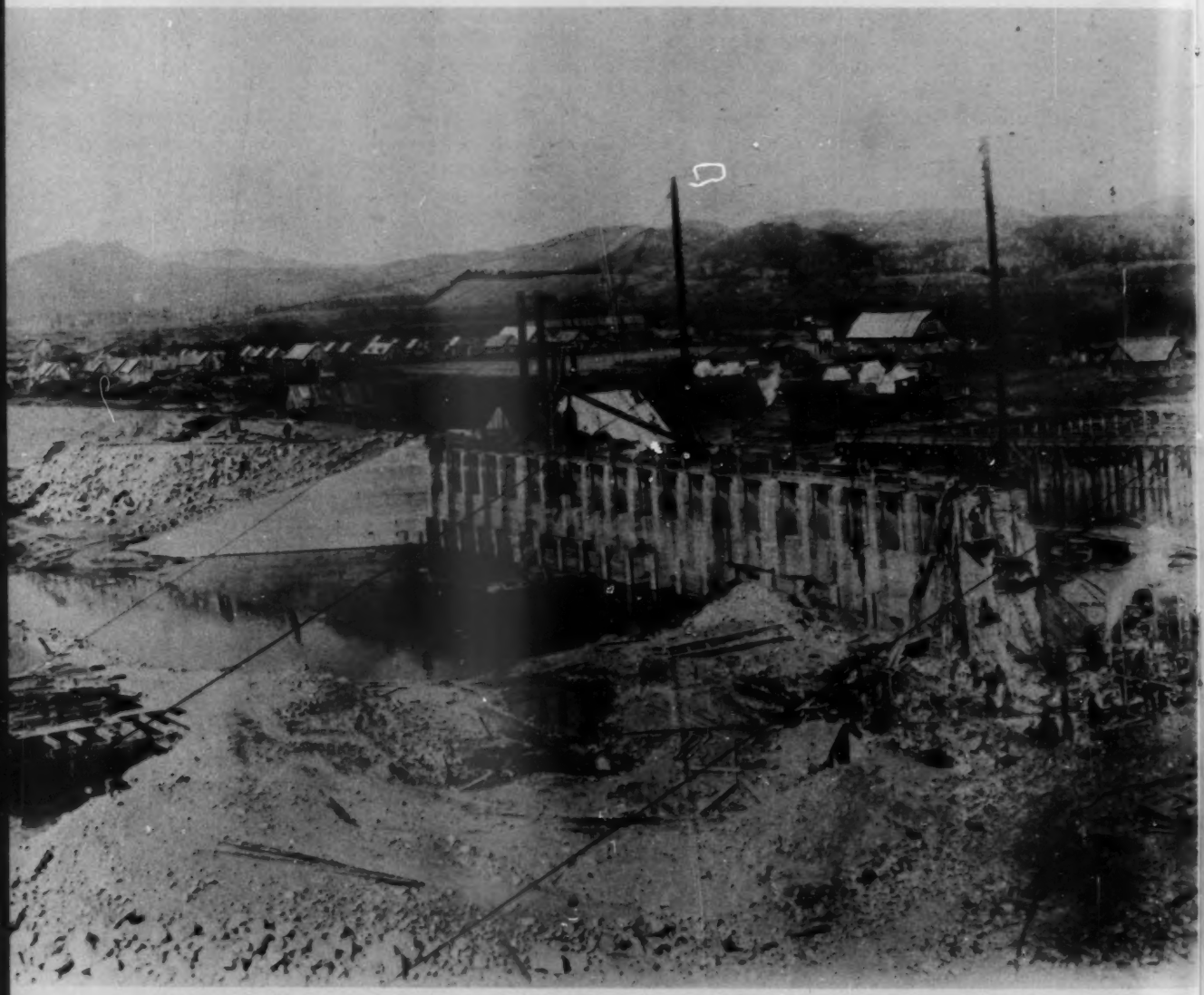
Construction of Jackson Lake Dam (summer of 1914), is aided by the cofferdam which holds back the river. Notice the Reclamation Service buildings in the center background.



Recollections on JACKSON LAKE DAM

Compiled by **John Markham**
Sonora, Calif.

THE growth boom struck Idaho shortly after the turn of the century with a force the inhabitants would feel for years to come. In 1905 the increase in irrigation developments in the Upper Snake River Valley and the formulation of plans to construct the Twin Falls North Side project clearly illustrated this growth. But, of more immediate importance, these developments illustrated that storage facilities would be required for the Minidoka project in the near future.

The Jackson Lake site in northwestern Wyoming, at the headwaters of the south fork of the Snake River, was adopted for the purpose of providing such storage facilities. It was decided first to construct a temporary timber dam designed to raise the surface of the lake 10 feet, thus providing a storage capacity of 350,000 acre feet, presumably sufficient for irrigation requirements for 4 or 5 years. This temporary dam would later be replaced by a permanent structure capable of providing greater storage.

The story surrounding the permanent Jackson Lake Dam is an interesting one, involving some interesting people.

In July 1909, two engineers rode horses through Yellowstone National Park seeking a site to build the permanent Jackson Lake Dam to replace the temporary cribwork structure near Moran, Wyo. Frank T. Crowe, Supervising Engineer for the Reclamation Service and a veteran of several Reclamation projects in southwestern Montana, and his assistant, Robert V. Sass, were the men who completed this assignment for the Reclamation Service.

These men inspected the site of the temporary dam at Moran, as well as a site about 5 miles away near the confluence of Pacific Creek and the south fork of Snake River. A dam placed here would have damned the Snake River near the south end of the Markham Ranch—now the Jackson Hole Wildlife Park—and would have made Jackson Lake much larger than its present size. (Over 30 years later, in 1940, test holes made in the rock near Pacific Creek were still visible.)

Temporary Dam Fails

On July 5, 1910, about 10 days before stored water was required for irrigation, the middle section of the cribwork of the temporary Jackson Lake Dam failed, releasing 194,000 acre-feet in a flood of 10,000 second feet. Several local bridges and a ferry 40 miles below were damaged but the wave of high water had dissipated by the time it emerged from the canyon.

Careful manipulation of the water in the equalizing reservoir at the Minidoka Diversion Dam prevented any serious damage to the canals or crops of the project.

The situation, however, required immediate action looking to the construction of the permanent storage dam, since an examination of the timber structure disclosed that the wood had rotted and was no longer dependable.

In a letter to me, Harley Coffin of Jackson, Wyo., recalled the event: "The summer the old dam went out, I was working as a helper to the cook whose first name was Ed. On the morning the dam broke we heard a big crash, ran to the door, and saw about 75 feet of the dam go."

Hence, with the survey for the permanent site completed in August 1909, Crowe and Sass returned to Helena, Mont. About 4 years later, Mr. Crowe told Mrs. Joseph J. Markham, my mother, that plans for a new damsite near Pacific Creek

Mrs. Johanna Waldin Markham, the first registered nurse in Jackson Hole, Wyo. (1910).

had been abandoned after compaction tests of the soil showed that the gravel was too loose and the soil too porous to support the weight of a permanent dam. For that reason, the dam was built at the site of the temporary dam at a cost of $453,300. It was completed in October 1916.

Joseph Markham—Timekeeper

Timekeeper, cost keeper and superintendent (July 1910–May 14, 1932) for the building and operation of Jackson Lake Dam was Joseph J. Markham, my father, then only 20 years old. Also serving as the purchasing agent, he bought most of the hay, grain, and beef at Jackson Hole.

Joseph J. McEnroe, a friend of my father, who had traveled West with him from New Britain, Conn., was hired by Mr. Crowe to be the Chief Clerk from July 1910 through July 1911. Mr. McEnroe later became Father's brother-in-law.

Progress Is Evident

Signs of progress were cropping up everywhere. A telephone line from Ashton to Moran was built in early August 1910 and part of the phone line from Squirrel Meadows to Ashton was still being used in 1930.

Douglas Rodeback, who founded the *Jackson Hole Courier* in 1909, estimated the population of Jackson to be 200 at that time, so the estimated 400 men which the Reclamation Service hired in early August and September of 1910 tripled the population of Jackson Hole.

Work crews, an office, and a warehouse were established at Ashton in late July and early August of 1910. Way stations, or overnight stops, were built at Squirrel Meadows, Cascade Creek, and the Snake River ford. By mid-August of 1910 the Reclamation Service at Moran had started the construction of a hospital, four barns, and an office building, plus 19 other buildings, making a total of 25 buildings erected in 1910–11 to house all the men and equipment needed to build the permanent Jackson Lake Dam. Lumber and supplies, including the gates for the dam, were being hauled 75 miles from Ashton to Moran over the 8,429-foot Teton Pass to facilitate the beginning of the dam.

Also in 1910, Mr. Crowe hired Dr. Joseph Hughes Shaw and Miss Johanna E. Waldin to be the first resident physician and nurse at the hospital. Dr. Shaw and Miss Waldin took care of the numerous patients at Moran, as well as many of the local residents of the northern part of Jackson Hole.

Times were so desperately hard in Jackson Hole during the years until 1930 that the residents hardly felt the effects of the depression. Even this national catastrophe didn't change things much in Jackson Hole.

Herbert James McVicker hauling a turbine from Ashton,

Reclamation Service employees and freighters from Ashton worked all winter of 1910–11 for $2.50 per day. Miss Waldin soon married Joseph J. Markham, Sr. Her starting pay as a nurse was $1.25 per week; she later received $90 per month for working every day of the month as the first registered nurse in Jackson Hole.

Nurse Markham did not charge anyone for her help, but one time she delivered a baby, now a prominent cattleman, and was offered a dozen eggs. She said, "I was so surprised, I accepted them." From 1920 to 1932, she treated numerous bear bites on people traveling south from Yellowstone Park to Moran. Every summer there would be several such victims who tried to feed bears in the park.

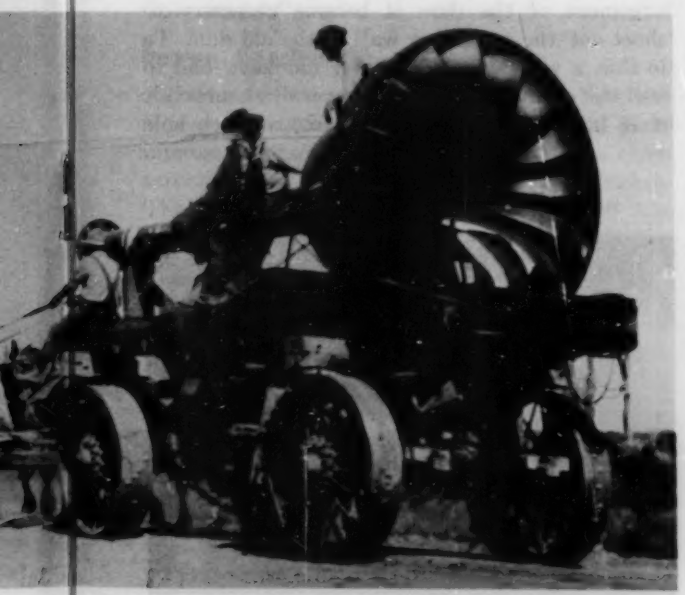
On December 15, 1910, Robert V. Saas, Sr., married Miss Libby Lzicar, formerly of Crawford, Nebr., and they returned to Moran a few days later. Mrs. Sass told me in her letter of May 7, 1968, that "when the dam was built in 1910–11, Bob was in charge of concrete work. They poured cement in 40 degrees below zero weather and had huge fires going in big stoves to prevent the cement from freezing."

Bob Sass, Jr., mentioned that several packrats chose his parents' home as a winter domicile. After Bob Sr. had tried to trap and shoot them without much luck, he caught several domestic cats that had gone wild and turned them loose in the house to prey upon the rats. Unfortunately, the cats ran wild inside the house; then Mr. Sass had the problem of getting rid of both the cats and the rats.

Joseph James Markham, timekeeper, cost keeper and superintendent for the building of Jackson Lake Dam.

Wild game and fish were easily obtained and trought could be caught from any stream large enough to water a horse. This lasted until 1940; then the catch began to decrease. During the construction period between 1910 and 1911, one could catch numbers of Mackinaw trout in Jackson Lake and could keep them fresh by simply laying them in any convenient large snowbank—the "pioneer deep freeze."

from Ashton, Idaho to the Ashton Dam in August 1916.



Large Freight Haul

In mid-October 1911, Joseph Hollis "Hall" Egbert, who had been hired to supervise all freighting from Ashton to Moran, his son Russ, and a crew of freighters hauled the gears to a hoisting engine and a carriage track weighing 8,200 and 5,500 pounds, respectively, in one of the classic freight hauls of all time.

In 1914, another important freighting took place when Hall Egbert, Will Steingraber, and John Blanchard of Victor, Idaho, and a crew of freight men hauled six huge boilers over the Teton Pass through snow 15 feet deep. Temperatures went as low as 63 degrees below zero in February, but work on the dam continued year round.

Robert V. Sass found trout plentiful in Jackson Lake in 1914.

In May 1914, a sawmill was started at Moran to build forms for cement work and to house personnel who worked on the "third"* Jackson Lake Dam.

Unfortunately, the mill was destroyed by a fire of unknown origin just a short time later. Edward Trafton, who worked at various jobs including working at the sawmill, was accused of burning down the sawmill, but this was never proven. Interestingly enough, however, Trafton was later convicted of robbing several stagecoaches in Yellowstone National Park.

Soon after the burning of the sawmill, it was rebuilt and operated through October 1916. I was later told that the mill had to be closed during the winter of 1914 through the winter of 1916 because the logs which floated across Jackson Lake during those years froze so hard they could not be sawed.

Balderston Narrative

William Balderston, a family friend since May 1914, gives an interesting account of some of his experiences relative to building of the "third" Jackson Lake Dam from 1914 to 1915.

*The "second" or permanent Jackson Lake Dam, built in 1910–11, replaced the temporary Jackson Lake Dam, built in 1906–07; the "third" Jackson Lake Dam was an enlargement of the "second" dam.

He lived in his native town of Boise, Idaho, and spent most of his summers during his high school years working with surveying crews in the southern part of the state. In 1914, he received an appointment to West Point from Senator William E. Borah, but did not enter because of his father's death.

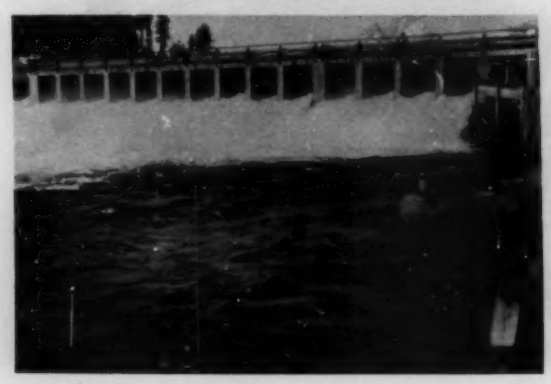
"Our family had a close friend," wrote Balderston, "who lived near us in Boise, A. J. Wiley. He was a well-known consulting civil engineer. He had done much work for the Reclamation Service and it was through his office that I first secured a job as a rodman on a surveying crew at the Jackson Lake enlargement project.

"I will never forget the first time we got a full view of the magnificent Teton Range as we worked our way up the valley. It made such an impression on me that when I got back to the University of Wisconsin 2 years later, I wrote a theme in my English class describing the trip and my professor was so impressed with my description of the Teton Mountains that he put me in the advanced English class.

"After I left the dam in the fall of 1915 and took a sheep train back to Madison, Wis., to attend the University of Wisconsin Civil Engineering College, I met my future wife, Susan B. Ramsey, whose mother has always said that I wooed and won her by my tales of Jackson Hole."

Mr. Balderston also described some of the construction work: "During construction of the enlargement of the dam it became necessary to 'shoot out' the west wing wall of the old dam. To do this, a whole crew of 'power monkeys' had to drill the entire face of the wing wall at intervals of 18 inches with hand drills and load each hole

The dam succeeds in holding back the Snake River.



Early stages of construction of the permanent Jackson Lake Dam.

with dynamite. When it came time to set off the charge, a group of us, including Frank Banks, (later to be Construction Engineer for Grand Coulee Dam) got under the sluice tunnel under the old dam. The chief powder man came into the tunnel, pushed the handle and set off a terrific charge, which nearly deafened everyone in the tunnel. After the 'shot,' nothing was left of the wing wall but the reinforcing steel."

Balderston had been seen around camp with a small camera, and was appointed official progress photographer for the construction project. He said, "I designed and, with the help of a carpenter, built probably the first darkroom in Jackson Hole and started taking progress pictures for the Government."

Beaver Poacher

Balderston also wrote: "Beaver Tooth Neal was a frequent visitor in the camp and was of great interest to everyone because he was such a character and had a reputation as a beaver poacher. The game wardens used to catch up with him quite often and he had to resort to special tactics to get his illegal skins out of the valley.

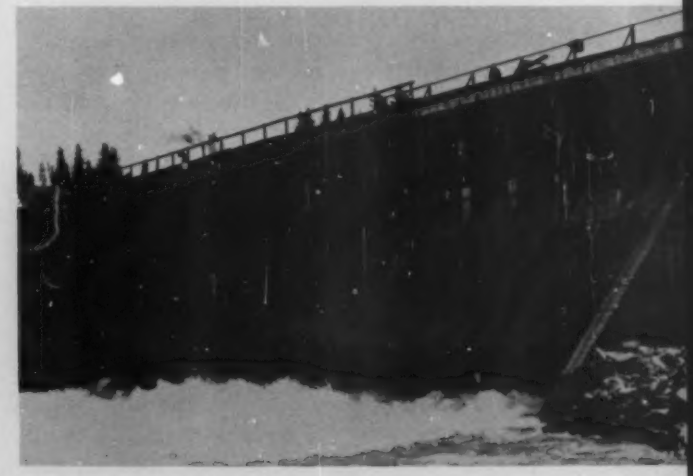
"The story was told that at one point, two officials of the dam were headed out to Ashton over the Reclamation road. Beaver Tooth asked them if they would take out his bedroll as he was going out on horseback and did not have room for it. They willingly took the bedroll out and left it at the warehouse in Ashton, whereupon Beaver Tooth came in a few days later and picked up the 'bedroll.' It was discovered to be pretty well filled with beaver skins."

Only 75 months after the first work began on the permanent Jackson Lake Dam, the dam as well as the 45 Reclamation Service buildings were completed. This marked the end of a thrilling era—an era which resulted in greatly improved water facilities.

"It was not until 1948," Balderston wrote me, "33 years later, that I was able to return to Jackson Hole with my wife and our two sons. There had been a great many changes, but thanks to the foresight and generosity of the Rockefeller family, the natural beauty of the valley had been preserved for all Americans to enjoy."

The Rockefeller family was instrumental in creation of the Teton National Park, the boundaries of which include the Bureau of Reclamation reservoir, Jackson Lake. * * *

Lower face of Jackson Lake Dam.



An aerial view of Jackson Lake Dam and Reservoir at the base of the Teton Mountain Range as they look today.

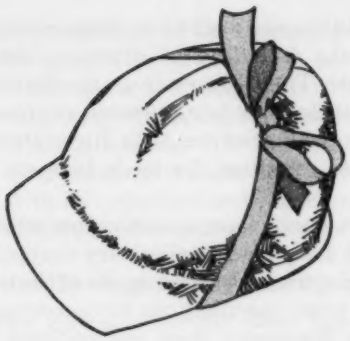
The stories conveyed to us through John Markham's papers, dealing with the construction of the temporary, permanent, and third Jackson Lake Dams, portray a myriad of interesting personalities. It is to these people that we owe a great deal. As a result of their willingness to work under the most extreme conditions, we now have the enlarged Jackson Lake and the many benefits it holds for us today.

Jackson Lake has been a major contributor to the Minidoka project's crop production. Since 1909, it has aided in the production of over $3⅓ billion worth of crops. As a recreational facility, Jackson Lake has excelled as a part of Teton National Park. In 1970 alone, this park hosted tourists for nearly 4 million visitor-days which included such activities as sightseeing, picnicking, camping, swimming, waterskiing, boating, and fishing.

The effectiveness of the lake is partially due to the ability of the Bureau to maintain it at an appropriate and useable level during the park tourist season. Early each spring prior to the snowmelt, the dam's gates are opened for drawdown. This provides the reservoir with additional space to accommodate the spring snowmelt which occurs in May and June. Since controlled amounts of water are released downstream, floods are averted.

After the May–June refill, the lake's surface is lowered slightly in July, August, and September (approximately 6 feet prior to Labor Day and another 4 feet after the holiday). The lake level is then stabilized from the first of October until spring.

This controlling of the level does not seriously affect boating or any other water sport on the lake. It merely prevents flooding during the peak runoff periods. # # #



A RIBBON ON MY HARD HAT

WHAT do a civil engineer, a hydraulic engineering technician, a fiscal officer, a technical editor-writer, and a geologist have in common? Generally little, but a particular group of such individuals have much in common—they all are women and all are employees of the Bureau of Reclamation.

Therefore, those who still believe a woman's proper place is only in the home had better take a second look at what is being achieved by these females who share their talents and energies with the Bureau of Reclamation. The projects these women help to design, construct, and operate have aided water users for years by developing western water and land resources.

The Civil Engineer

In 1948, shortly after the Bureau opened its Upper Missouri Projects Office in Great Falls, Mont. (Region 6) it hired a young civil engineering graduate from the University of Texas. Lucy Pettapiece has since worked on a number of assignments in that office.

Until recently, almost all of these assignments were concerned with bringing irrigation water to the arid lands of Montana. When she arrived, studies were in progress on the proposed Lower Marias Unit in central Montana. Tiber Dam was constructed to impound a water supply for the Unit. However, plans for completion of the Unit had not been finalized; Lucy took part in completing them. This included laying out proposed canals and laterals, selecting structure sites, preparing designs, and estimating quantities of material needed and the costs of construction.

20 Years Later

In 1968, the Bureau completed a storage dam for the Bureau of Indian Affairs 4 miles northwest

Lucy Pettapiece points out a transverse groove designed to control cracking in slipform concrete lateral lining on the Helena Valley Unit. The lining was installed to cut water losses from an existing lateral.

Lower Two Medicine Dam, Mont.

of East Glacier, Mont. The structure on Two Medicine Creek replaces a dam washed out during the floods of 1964. Civil engineers, including Lucy, worked hard to obtain survey data necessary to plan recontruction of the destroyed dam.

Runoff from a portion of Glacier National Park is regulated at Lower Two Medicine Dam for irrigation of approximately 23,000 acres in the Blackfeet Indian Reservation. Two gates in the overflow weir of the spillway release stored water for downstream diversion throughout the project area.

Other portions of Lucy's time has been spent on drafting annual construction contracts for installing buried membrane lining in canals on the Bureau's East Bench and Helena Valley Units.

This lining reduces water losses from the canals and, in the construction of drains, prevents water logging of the units' irrigated lands. New to these units, a program was started to install slipform concrete lining in the laterals.

The 63–foot-wide polyvinyl chloride membrane used on these projects was unfolded from the canal bottom and laid up the 2:1 slope, one side at a time. The loose sides are covered with material at the excavated 18-inch-wide anchor berm. Placement of selected cover material is made with a dragline to a depth of 16 inches. This PVC lining often runs nearly 800 feet long.

Now in the Design Branch of the Upper Missouri Projects Office, Lucy has been busy writing the construction specifications under which this construction work is performed.

In addition, she worked on recent studies to determine the feasibility of diverting the unused water from Tiber Reservoir on the Marias River into the Milk River to supplement supplies on the old Reclamation Service Milk River Project and to provide irrigation for lands between the two rivers.

Canyon Ferry Dam is another major structure for which Lucy made preliminary studies, such as determining the back water curves of the reservoir. She also wrote specifications for removing gravel and rock fragments from the spillway stilling basin of the dam.

Lucy sees the Bureau as being far more diversified than it was years ago. "Almost since its beginning as the Reclamation Service, the Bureau of Reclamation has been primarily interested in irrigation, with power production and flood control as byproducts of its operations. Now its goals are broadening, and irrigation is just a part of the whole of the many benefits the Bureau produces."

East Bench Canal, Mont.

"Among water uses to be considered are municipal as well as industrial supplies. Interest in developing the large coal deposits of southeastern Montana and northeastern Wyoming plunged the Upper Missouri Projects Office into studies of the feasibility of using large-diameter pipelines to transport water hundreds of miles from Bureau reservoirs to coal fields, where a regulated water supply is vital to development.

"As another aspect of the diversified Bureau, UMPO is evaluating the needs, resources, and de-

velopment possibilities of the sparsely populated eastern Montana. After development possibilities have been determined, studies will be made of methods and costs of developing these resources of which water is only one.

"This diversification of Bureau interests, in conjunction with its competent and experienced engineering staff, can lead to undreamed of new goals."

The Hydraulic Engineering Technician

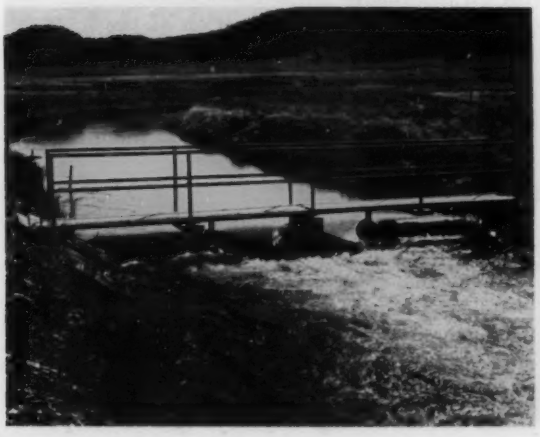
Learning why a particular canal has a 3-foot radial gate and another has a 4-foot rectangular gate, why Yuma is concerned about stormflows, and why a certain vehicle has two fan belts are only a few of the things one learns when one becomes a hydraulic engineering technician.

Ruth M. Funk, a hydraulic engineering technician in region 3 at the Yuma Projects Office has not only learned much from her job, but has been given ample opportunity to apply her knowledge.

The responsibilities of the Water and Land Operation Division which directly concern her include: A deep well pump drainage program. One objective of this program is to maintain safe ground-water levels in the area and to coordinate the drainage flows and the salinity levels of these flows with the requirements of water to be delivered to Mexico. The drainage wells are in the Welton-Mohawk, South Gila Valley and Yuma Mesa areas.

Delivery of irrigation water to farms on Bureau-operated irrigation systems is another objective of the program. This includes processing water orders, preparing water delivery schedules, operating water delivery and distribution systems, and maintaining water accounting records. Also included is the scheduling of requirements for water diverted at Imperial Dam for the irrigation records required by the Supreme Court decree in the case of *Arizona* v. *California*. And, finally, this includes performing hydrographic activities such as reading water-stage records; measuring flow of canals, laterals, sluiceways, and drains; measuring discharge flows from drainage wells and channels and making the required hydraulic computations and reports.

Helena Valley Canal, Mont.



Her final responsibility is involved with the maintenance of facilities at Imperial and Laguna Dams, Senator Wash Dam and Pump-Generating Plant, and Bureau-operated facilities of the Gila and Yuma projects.

As a hydraulic engineering technician, Ruth supervises the preparation of various recurring and special reports, which include data on flow and diversion, return flows, power and operation, and a variety of hydrographic records. She prepares a schedule of water requirements for weekly irrigation for diversion at Imperial Dam for both Government and water district operated projects consisting of approximately 180,000 acres—comprised of five irrigation districts and two Bureau-operated units. She also maintains hydrographic records of daily operations by the districts and Bureau-operated units, including waste, usage, rejected orders, etc.

"I had absolutely no idea what the functions of the USBR were when I began working for them," said Ruth. "But, since I have an insatiable curiosity about most everything of which I am not knowledgeable, the Bureau opened the doors for me to a vast unknown world of maintenance, construction, engineering, irrigation, administration, heavy-duty mobile equipment, rivers, dams, etc. Do I like my job? Believe me—I love it!"

The Fiscal Officer

Nedra A. Blackwell, Chief of the Fiscal Services Branch in Region 1, finds working for the Bureau a rewarding and challenging experience. Although most people think of Reclamation as being a man's world of engineers, the world of finance in Region 1 is mostly populated by women. Moreover, Nedra has the distinction of being the first female fiscal officer in Region 1.

She is responsible for certification and payment of all claims for Region 1 and all collections from

Nedra A. Blackwell, Chief of the Fiscal Services Branch in Region 1, completes a voucher sheet.

repayment contracts, and water and power sales. The payroll is also a major part of the Fiscal Services Branch and the changes it has undergone from a manual operation to data processing have been of prime interest to her. Her monthly reconciliation of fund control accounts with the Treasury Department and the Regional General Accounts Branch always presents a satisfying conclusion to the month's activity—particularly if they balance on the first try!

Whether certifying a $4 million contract payment, a $10 travel voucher, or attempting to interpret Comptroller General decisions, Nedra approaches each task with enthusiasm and sound judgment. "I am proud of being a part of Reclamation and particularly proud that Reclamation is one Government agency which directly benefits the people and is nearly self-supporting from the income derived from contract repayments and water and power sales."

The Technical Editor-Writer

Filling a position that ranges from editing test plans and reports at Dugway Proving Ground, Dugway, Utah to preparing environmental statements for each unit of the Central Utah project is an exciting career for Diane L. Jarvis.

A technical writer translates the technical language of the scientist or engineer into terms understandable to the layman. "A rewarding aspect of my job is knowing that with each finished project I've contributed to the establishment of an easier communication between scientists and engineers and laymen," commented Diane.

"My work with the Bureau has been especially interesting and challenging. With each new assignment, I'm presented with an opportunity to increase my knowledge in many categories. For example, our branch has been responsible for writing definite plan reports for the six units of the complex and multipurpose Central Utah project (Region 4), a participating project of the Upper Colorado River Storage project.

"Another challenge is the environmental statements we have been working on which define and assess the impacts the project will have on the area's environment. Policies and guidelines for these statements are in the formative stage and much of the groundwork is still being laid. It is exciting to participate in this quest for quality, which is so important to present and future generations."

The Geologist

A 1968 graduate of St. Louis University, Frances J. Landwehr came to work for the Bureau at Grand Coulee Third Powerplant in September following her graduation.

Since that time her work has consisted of a variety of outdoor and indoor activities. "Outdoors," explains Frances, "I work on detailed geologic investigations of the construction site and surrounding area. This includes mapping the land as excavation progresses, identifying and evaluating soil and rock types for geologic condition and content, inspecting drilling operations, and logging core. I also work on selecting base materials for fill placement.

"Indoors, there is preparation of the interpretations and exploration results. I also compile data for monthly geological and final construction reports.

"I enjoy working both indoors and outdoors. When there is adverse weather, one finds something inside to do, and when the weather is nice, one looks for something outside. Then there are those times when you end up outdoors in a blizzard, but that is OK, too!!"

When she first arrived at the geology department, there were approximately 30 drillers and drill helpers. Most of them were apprehensive during her first day in the field, but after numerous stares and much laughter, they began to accept her.

Other geologists claim they can scream for help while hanging from a cliff by their fingernails and no one will notice, but Frances stumbles and everyone looks. "They exaggerate a bit, but I do believe I am probably one of the few geologists who can convince a driller to carry core boxes for me.

"On the whole, most of the people I associate with accept me as I am. There are some, however, who don't know I'm a geologist and wonder why I always wear jeans. One man, after seeing my desk, asked where my typewriter was.

"I get a lot of ribbing, but I enjoy the work very much. If I didn't, I wouldn't be here," she summarized.

Reclamation's Diversified Ladies

Far from being stereotyped, many of Reclamation's females are extremely diversified. They, as well as numerous others in different fields, all contribute to the Reclamation program. Our hats, whether hard or soft, with or without ribbons, are off to these ladies. # # #

Diane L. Jarvis, Technical Editor at Dugway Proving Ground, Dugway, Utah, finds her job challenging and rewarding.

Canyon Ferry Dam, Mont., unlike most other dams, knew the touch of a female civil engineer.

NEWS NOTES

Navajo Project Environmental Draft

A draft of a consolidated environmental statement for the Navajo thermal-electric project in Arizona, Utah, and Nevada has been released by the Department of the Interior.

Commissioner of Reclamation Ellis L. Armstrong said the draft covers all aspects of the project, including the Navajo Generating Station, the Black Mesa, and Lake Powell Railroad (formerly called the Navajo-Black Mesa Coal Haul Railroad), the Black Mesa Coal Mining Operation, the Southern Transmission System (formerly called the Navajo-Phoenix Transmission System), and the Western Transmission System (formerly called the Navajo-McCullough Transmission Line).

Prepared in compliance with the National Environmental Policy Act of 1969, a consolidated final statement will be submitted to the Council on Environmental Quality following review of the draft by Federal, State, local, and private agencies, including conservation and environmental groups.

The consolidated draft statement is a cooperative effort involving the Bureau of Reclamation and the latter groups.

Illinois U. Gets Skywater Contract

The Bureau of Reclamation has awarded a 5-year contract to the University of Illinois for research and planning of future programs of precipitation management designed to increase water supplies and crop moisture in southern Illinois.

The Commissioner explained that the contract is a significant step in Interior's development of a national program of atmospheric water resources research and is being undertaken as a part of the Bureau's Project Skywater effort to develop cloud-seeding as an efficient water resources tool.

The work will be directed by Stanley A. Changnon, Jr., head of the Atmospheric Sciences Section of the Illinois State Water Survey.

"This project achieves two significant firsts," the Commissioner explained. "It is the first comprehensive investigation of cloud-seeding potential in the Midwest, and it represents the first basic research of the treatment of winter storms over nonmountainous areas to recharge soil moisture and shallow groundwater aquifers."

SRP Presented Certificate

During his visit to the Salt River project on November 8, while accompanying Spain's Minister of Public Works Gonzalo Fernandez de la Mora, Commissioner Armstrong presented a special Certificate of Appreciation to the personnel of the Salt River project, signed by Secretary of State William P. Rogers and Secretary of the Interior Rogers C. B. Morton. Both expressed their appreciation for the outstanding record of hospitality and technical training which the project has offered the many foreign visitors to Arizona.

Nelson U.S. Representative

Harold T. Nelson, former Regional Director, Boise, Idaho, has been appointed U.S. Representative to the Columbia Basin Interstate Compact Commission by President Nixon. Nelson succeeds Thomas R. Newell, who resigned.

Commissioner Armstrong said Nelson's professional experience and background, including personal knowledge of water problems of the area, make him admirably suited to be the Federal representative in deliberations of the Commission.

The Commission was authorized by the Congress in the early 1950's to negotiate and enter into a compact for the disposition, allocation, diversion and apportionment of the waters of the Columbia Basin and its tributaries.

More Plastic Tubing

During the week of October 18–22, about 4,000 feet of corrugated plastic drain tubing (6 and 8 inch diameter) was installed on proposed irrigable land in the Oakes Area, N. Dakota. This work was performed by Eli Hershberger, Inc., with a continuous chain trencher. Mr. Hershberger said the machine used for this job is capable of laying pipe to a depth of 6 feet. The conditions encountered here are quite representative of those on the Garrison Diversion Unit. Part of this drain will have a gravel envelope and part will not. (Editor's Note: In the November 1971 issue of the *Era*, an article titled "Region 7 Launches Program To Reduce Subsurface Drainage Costs," gives a full account of what Region 7 has done with this type of plastic tubing).

Howell Joins Reclamation

Dr. Wallace E. Howell, distinguished meteorologist, inventor, and scientific director of the Mount Washington Observatory in New Hampshire, joined the staff of the Bureau of Reclamation's Engineering and Research Center at Denver, Colo., in November.

Dr. Howell, 57, now heads the Research and Development Branch of the Bureau's Division of Atmospheric Water Resources Management.

Dr. Howell has been a private consulting meteorologist with offices at Lexington, Mass., in addition to his post as scientific director and former president of the Mount Washington Observatory. The observatory is a private, nonprofit institution where cloud physics and icing research studies have been in progress since World War II.

As founder and principal officer of a meteorologic firm then bearing his name, Dr. Howell directed the operation of some 60 weather modification projects in the eastern United States and Canada and in a dozen foreign nations from 1951 to 1967. His firm also pioneered a number of cloud-seeding techniques before a corporate merger in 1967.

Dr. Howell recently invented a radically new type of anemometer based on its ability to sense the momentum of moving air. He holds two patents on instruments used in meteorologic work. He has authored more than 50 technical papers and publications on the science of meteorology, and in 1968 was honored by the American Meteorologic Society for outstanding contributions to applied meteorology.

Elephant Butte Makes Final Repayment

This 102,082-irrigable-acre irrigation district, one of the first Reclamation projects to be authorized, made its final repayment in September 1971.

Initially authorized on March 4, 1907, under the provisions of the Reclamation Act of 1902, the total project cost was $6,551,330.

In June 1918, the Elephant Butte Irrigation District assumed obligations of the Elephant Butte Water Users Association. This included the costs of the irrigation facilities in New Mexico and a portion of the costs of Elephant Butte Dam. By contract dated November 9, 1937, the district was relieved from repayment of the cost of Elephant Butte Dam in return for relinquishement of its interest in power development.

Repayment charges were spread over 40 years from the date the first installment became due under the original contract, exclusive of several years of moratorium. The first payment was due March 1, 1923, and the final payment was due September 1, 1971. The project is now paid in full.

# # #

Answers To Water Quiz:

1—Tigris-Euphrates Valley in Mesopotamia and Nile Valley of Egypt. 2—b. 3—a, c. 4—c. 5—Salt particles unite with supercooled water droplets, causing both an increase in the size of the cloud and measurably greater rainfall than from nonseeded clouds.

MAJOR CONSTRUCTION AND MATERIALS FOR WHICH BIDS WILL BE REQUESTED THROUGH FEBRUARY 1972*

Project	Description of work or material
Central Utah, Utah.	Constructing Currant Creek Dam, a zoned earthfill structure about 130 ft high and 1,600 ft long. The outlet works will consist of an intake structure, a 12-ft diameter, steel-lined conduit, a gate chamber and shaft, a 16-ft 9-in. diameter horseshoe conduit with a 12-ft diameter steel pipe, a control structure, and a stilling basin. The outlet works will discharge to a 10-ft 6-in. diameter buried pipeline. The spillway will consist of an inlet structure and a 10- by 20-ft conduit on the dam embankment, and a stilling basin with a service bridge. Work will also include improving 3.3 miles of road, constructing 0.6 mile of road, and constructing a boat ramp. On Currant Creek, about 13 miles northwest by road from the Currant Creek crossing of U.S. Highway No. 40, in Wasatch County, Utah.
Central Valley, Calif.	Constructing about 87 miles of pipelines ranging in size from 12 through 72 in. in diameter with heads varying from 25 through 225 ft, 7 pumping plants, 1 water screen and recirculating structure; and installing 40 vertical-shaft pumping units with a capacity range of 21 to 2.8 cfs with heads up to 150 ft. Work at the pumping plants will include furnishing and installing pumping units, motor control equipment, traveling and stationary water screens, gate valves, check valves, steel manifolds, air chambers, and watermeters and structures. Near Huron. Westlands Pipe Distribution System Contract No. 10, Laterals 28–2.0, 29–1.0, 30, 32, 33, 36, 37, 2R, 13R, and 17R.
Do	Constructing about 5.2 miles of unreinforced concrete-lined canal with a 12-ft bottom width and a capacity varying from 725 to 425 cfs. Work will include constructing two 102-in. diameter precast concrete siphons; three bridge crossings; three turnout structures; five overhead steel pipe cross-drainage structures; one culvert cross-drainage structure with stilling pool; one reservoir inlet structure; three oil and gas line crossings; and three irrigation crossings. About 5 miles northeast of Coalinga, Coalinga Canal, Reach 2.
Do	Disassembly and reassembly of six main pumping units; machine work necessary for modification of the lower pump bearing on each unit; and provision for four handholes and one manhole for each unit. Thirteen miles west of Los Banos, O'Neill Pumping plant.
Do	Furnishing and placing creek run cobble fill and riprap blanket of undertermined length along the west shoreline of Red Bluff Reservoir, and providing about 80,000 sq ft of slope protection at the Tehama-Colusa Canal settling basin. Two miles southeast of Red Bluff.
Do	Furnishing, installing, and testing one 13.8-kv armature winding for a 60,000-kva generator, Folsom Powerplant.
Columbia Basin, Wash.	Constructing 13 miles of buried pipe drains and one pumping plant. Fifteen miles northwest of Pasco, Block 16.
Do	Constructing 2.1 miles of concrete-lined canal with a bottom width of 10 ft; 19.5 miles of concrete-lined laterals with bottom widths of 4 and 2 ft; and 11 miles of unlined drains and wasteways with bottom widths of 6 and 4 ft. Pipe work will consist of 3,600 ft of 51-in. and 3,000 ft of 48-in. diameter precast concrete pressure pipe with a maximum working head of 75 ft; and 5,000 ft of 36-in. diameter and smaller precast concrete pressure pipe. Thirty-five miles west of Othello. Priest Rapids and Block 251 Laterals, Station 2347+01.1 to Station 2461+54.5.
Do	Constructing about 2.2 miles of gravel-lined "V" type channel with appurtenant structures for highway and railway crossings to serve as a wasteway for WB38B lateral, and modifying a check structure on Wahluke Branch Canal, Block 25, east of Mattawa.
Do	Constructing 2.6 miles of 30-ft bottom width unlined channel with rock-lined drop structures and drain inlets; furnishing and installing 1.5 miles of Type B barbed wire fencing; and grass seeding banks. Three miles southwest of Eltopia. Esquatzel Coulee.
Do	Constructing concrete foundations; furnishing and erecting steel structures; installing a 15-kv primary unit substation; furnishing and installing two 115-kv circuit breakers, and associated electrical equipment; constructing about 2 miles of concrete-encased duct bank; furnishing and installing about 4 miles of 11.95-kv feeder circuit in duct bank and about 3 miles of direct-buried 11.95-kv feeder circuits; modifying existing switchyard; and grading, surfacing, and fencing an extension to the yard. Left abutment area of Grand Coulee Dam. Grand Coulee 115- and 11.95-kv switchyards and 11.95-kv feeder circuits.
Do	Control boards for control of the 500-kv switchyard and generator units G19, G20, and G21, Grand Coulee Third Powerplant.
Central Valley, Calif.	Five modification assemblies for existing governors, including governor control columns with associated equipment, permanent magnet generators, necessary controls for operating from a remote control board, and governor instrument panels for mounting on existing actuator cabinets. Shasta Powerplant.
Fort Peck, Mont.	One 2-channel, single-sideband carrier-current system between Dawson County and Custer Substations.
Fruitland-Mesa, Colo.	Constructing 13 small reinforced concrete structures and 0.56 mile of earth-lined canals with bottom widths of 10 and 8 ft; and furnishing and laying 2,730 ft of 24- and 30-in. precast concrete culvert pipe with Type R joints, 1,345 ft of 30-in. precast concrete pressure pipe with a maximum head of 150 ft, and 1,575 ft of 42-in. precast concrete pressure pipe with a maximum head of 225 ft. Nine and 13 miles southwest of Crawford. Gould Canal, Siphon Replacements.
Fryingpan-Arkansas, Colo.	Constructing Pueblo Dam, a zoned earthfill and concrete structure about 190 ft high, 10,000 ft long, with a concrete stilling basin about 550 ft long. The major excavation for the concrete and earth embankment sections for the dam was performed under a prior contract, leaving only minor rock and common excavation to be performed. Normal diversion of the river will be accomplished by passing the flow of the river through two diversion conduits built into the existing concrete plug constructed in the river gorge. The concrete portion will consist of 23 massive-head buttresses with an uncontrolled central spillway, totaling 1,750 ft in length. Drilling and grouting of the foundation rock of the concrete dam and stilling basin will be followed by drilling of drainage holes. The structure will contain six outlets controlled by high-pressure gates. Earth dam embankments, predominantly rolled earthfill, which wrap around the ends of the concrete dam are to be constructed, totaling about 8,480 ft in length. All cutoff trench construction beneath the earth embankments was completed in the prior contract. The zoned earthfill embankments will have a downstream face layer of sand, gravel, and cobbles with tow drain systems. The upstream faces will be covered by riprap. A concrete shaft and shafthouse will be constructed in the right abutment of the earth dam. On the Arkansas River, about 8 miles west of Pueblo.
Do	Improving 3 miles of county road by widening roadway to 22 ft, placing 6-in. surface of select roadway material, installing corrugated-metal-pipe culverts and extending existing corrugated-metal-pipe culverts; constructing a 22-ft wide, 28-ft long reinforced concrete slab bridge, and widening existing stone masonry abutments. Thirty miles east of Basalt.
Lyman, Wyo.	Constructing the zoned earth and rock fill China Meadows Dam with a height of about 105 ft above the bed of the river, and a crest length of about 2,350 ft; a dike about 43 ft high with a crest length of about 1,000 ft; a reinforced concrete outlet works structure consisting of a 5.5-ft diameter diversion conduit, 150 ft long; an intake structure; a 5.5-ft diameter, steel-lined upstream conduit, 170 ft long; a gate chamber housing a 2-ft 9-in. by 2-ft 9-in., high-pressure, emergency slide gate; a 7-ft diameter, horseshoe-shaped, downstream conduit containing a 36-in. inside-diameter, steel outlet pipe 380 ft long; a control structure and house with a 2-ft 9-in. by 2-ft 9-in., high-pressure, control slide gate; a rectangular stilling basin 45 ft long, 10 ft wide, and 19 ft deep, which will empty into a riprap-lined outlet channel; a 16-in. diameter bypass pipe from the outlet works to a 14-in. diameter, jet-flow gate; and 8-in. diameter bypass pipe connected to 16-in. pipe leads into a 12-in. diameter precast concrete pipe placed in a back-filled trench, 6,300 ft long; a reinforced concrete spillway structure consisting of a 70-ft long, side channel, overflow crest; a 420-ft long rectangular chute varying from 18 to 32.5 ft wide; a rectangular stilling basin 102 ft long, 32.5 wide, and 31 ft deep, which will empty into a riprap-lined outlet channel; and a gravel-surfaced access road to the damsite and a gravel-surfaced access road between the dam and the dike. On the East Fork of Smith's Fork River, about 25 miles south of Mountain View, Wyo., in Utah.
Mountain Park, Okla.	Constructing a bridge, and earthwork, corrugated-metal pipe and concrete box culverts, guardrail, fencing, and bituminous surfacing for 5.1 miles of relocated highway. The bridge, to cross Glen Creek, will have a 40-ft roadway between barriers, two 70-ft 6-in. continuous spans using rolled beam sections and a 6.5-in. reinforced concrete deck, and a superstructure supported on timber pile footings at the abutments and center pier. Beginning about 4.5 miles north of Mountain Park, U.S. Highway No. 183 and Glen Creek Bridge.
Do	Constructing an access road to the Mountain Park damsite. Near Snyder.
Pick-Sloan Mo., Kans.	Constructing about 4.7 miles of 6-in. subsurface drain varying in depth to 11 ft; about 1.6 miles of open drain with bottom widths varying from 6 to 4 ft; 20 concrete manholes; and 8 corrugated-metal-pipe outlet structures. About 2 miles north of Courtland. Courtland 31–2–5.

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MAJOR CONSTRUCTION AND MATERIALS FOR WHICH BIDS WILL BE REQUESTED THROUGH FEBRUARY 1972*—Con.

Project	Description of work or material
Pick-Sloan Mo., Kans.	Constructing about 4.2 miles of 6- to 12-in. subsurface drains varying in depth to 11 ft, 23 concrete manholes, and 3 corrugated-metal-pipe outlets. Six- and eight-in. corrugated-plastic drainpipe will be an alternate to concrete, clay, or asbestos-cement pipe for 2.3 miles of drain. About 4 miles south of Republic. White Rock 30-2-4.
Pick-Sloan Mo., Mont.	Constructing about 4.1 miles of dikes with a maximum height of 15 ft along the west side of the upper end of Canyon Ferry Lake. Near Townsend.
Pick-Sloan Mo., Nebr.	Stage 03 additions to Stegall Substation will consist of constructing concrete foundations; furnishing and erecting steel structures; and furnishing and installing a 3-phase, 230-kv, 25-mva reactor, and related electrical equipment. About 14 miles west of Gering and 3 miles south of Stegall.
Pick-Sloan Mo., N. Dak.	Constructing 20 miles of 1,950-cfs capacity canal with a 25-ft bottom width and side slopes of 2:1; a headworks structure with eight 120- by 120-in. cast-iron slide gates with motorized lifts and a 12- by 23-ft control house; a check structure with two 16-ft radial gates with motorized lifts; a structural-steel railroad bridge with concrete abutments; five highway bridges with precast-prestressed concrete abutments; five highway bridges with precast-prestressed concrete beams; 850 lin ft of 18- to 84-in. diameter corrugated-metal pipe; five turnout structures with chute outlets; berm drainage structures; cross drainage structures; highway and county road relocations; and a concrete rating section. Near Turtle Lake, McClusky, Reach 1.
Do	Constructing 16 miles of 1,950-cfs capacity canal with a 25-ft bottom width and side slopes of 2:1; five 20-cfs capacity turnouts; berm drainage structures; a 24-in. diameter cross-drainage structure; three bridges to be continuous structures consisting of two 53-ft 6-in. spans, one with a roadway width of 32 ft and the other two with 28-ft roadways; superstructures to be reinforced concrete deck slabs supported on precast-prestressed concrete box girders; substructures consisting of concrete solid wall piers and abutments, each supported on timber piles. Work will also include road construction consisting of 3 miles of gravel-surfaced county road relocation and 1.3 miles of bridge approach roads. The bridge approach roads are to be surfaced by gravel for about 1.3 miles and 0.5 mile with bituminous base. Near Turtle Lake, McClusky, Reach 2.
Pick-Sloan Mo., N. Dak.	Stage 04 additions to Carrington Substation will consist of constructing concrete foundations; furnishing and erecting steel structures; removing and reerecting a steel structure; relocating one 46-kv circuit breaker; furnishing and installing one 5.4-mvar shunt capacitor equipment bank, on 46-kv circuit breaker, and associated electrical equipment; and grading, surfacing, and fencing an extension to the yard. Stage 03 additions to Leeds Substation will consist of constructing concrete foundations; furnishing and erecting a steel structure; removing and reerecting steel structures; furnishing and installing one 5.4-mvar shunt capacitor equipment bank, one 60-kv circuit breaker, and associated electrical equipment. Carrington Substation is just northeast of Carrington; Leeds Substation is about 2.5 miles south of Leeds.
Do	Furnishing and laying about 3.3 miles of 27- and 30-in. diameter pressure pipe with heads ranging from 50 to 125 ft, and about 2.9 miles of 48-in. diameter pressure pipe with heads ranging from 50 to 100 ft; relocating 1,000 ft of sewer line, and numerous water, sewer, and communication lines within the city of Minot. The pipeline will have three railroad crossings and numerous road crossings. From 5 miles southeast of Minot to the Minot Water Treatment Plant. Sundre, Station 20+00 to Station 194+60, and Minot, Station 57+69 to Station 260+58.
Pick-Sloan Mo., Wyo.	Furnishing and testing programable master supervisory control equipment for the control of eight North Platte area powerplants from Caster Control Center. The master terminal is to be provided with color cathode ray tubes and will require limited graphic capability. (Additional technical details will not be available for discussion until the solicitation is issued.)

*Subject to change.

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-6893	Central Valley, West San Joaquin Div., Calif.	Dec. 9	EarthWork, pipelines and structures for Westlands Water District Distribution System, Laterals P20, P31, 31-1.5, 32, 36 and 37.	Granite Construction Co., Watsonville, Calif.	$4,091,939
DC-6896	Chief Joseph Dam, Chelan Div., Wash.	Nov. 12	Lake Chelan Pumping Plant, discharge line and regulating tank.	Bovee and Crail Construction Co., Paramount, Calif.	1,413,027
DC-6901	Pick-Sloan Missouri Basin Prog., Trans. Div., Mont.	Oct. 21	Construction of Terry Tap Substation, Shirley Tapline, and Shirley Tap, and modifications at Terry and Shirley Pumping Plants and switchyards.	Cochran Electric Co., Inc., Seattle, Wash.	222,712
DC-6904	Fryingpan-Arkansas, Colo.	Nov. 29	Generator/Motor for Mount Elbert pumped-storage powerplant, Unit No. 1.	Westinghouse Electric Corp., Denver, Colo.	2,230,421
DC-6905	Columbia Basin, Wash.	Oct. 18	Grand Coulee 500-kv switchyard, cable spreading yard, and transformer circuits, stage 01.	City Electric, Manson Construction & Engineering Co., and Osberg Construction Co., Seattle, Wash.	6,360,300
DC-6908	Pick-Sloan Missouri Basin Prog., Trans. Div., So. Dakota.	Nov. 1	Stage 08 additions to Sioux Falls Substation	United Power & Control Systems, Inc. Seattle, Wash.	285,859
DC-6909	Columbia Basin, Wash.	Dec. 22	Installation of pump-turbines, reverse flow wheel-mounted gates and appurtenant equipment, electrical installations, and modifications of outlets to existing discharge lines for Units P/G7 and P/G8 for Grand Coulee Pumping-Generating Plant.	Scott-Buttner Corp., Oakland, Calif.	1,922,779
DC-6910	Teton Basin, Lower Teton Div., Idaho.	Dec. 13	Teton Dam and power and pumping plant	Morrison-Knudsen Co., Inc., and Peter Kiewit Sons' Co., Boise, Idaho.	39,476,142
DC-6911	Pick-Sloan Missouri Basin Prog., Trans. Div., Nebr.	Nov. 2	Stage 02 Additions to Grand Island Substation	Cochran Electric Co., Inc., Seattle, Wash.	306,432
DS-6912	Columbia Basin, Wash.	Nov. 26	Armature windings for Generators at Grand Coulee Powerplants.	McGraw-Edison Co., National Electric Coil Div., Columbus, Ohio.	519,396
100C-1173	Chief Joseph Dam, Foster Creek Div., Wash.	Oct. 7	Replacement of pipe laterals	Washington Development Co., Seattle, Wash.	217,230
100C-1178	Columbia Basin, Wash.	Oct. 29	D20-107 drain system, Block 20	John M. Keltch, Inc., Pasco, Wash.	140,343
100C-1182	do	Nov. 22	D86-95 and D86-97 drain systems, Block 86	do	213,690
100C-1183	do	Nov. 12	Drains—Blocks 44 and 49	do	107,042
100C-1185	do	Dec. 10	D42-94, D42-97, D42-149, and D42-150 drain systems—Block 42.	Equipco Contractors, Inc., Ephrata, Wash.	129,943
200C-833	Central Valley, Delta Div., Calif.	Oct. 18	Installation of additional Pumping Units and related equipment in pumping plants No. 1, 2, 3, and 4, Contra Costa Canal.	M.G.M. Construction Co., Concord, Calif.	168,950
400C-488	Colorado River Storage, Ariz.	Dec. 16	Terrazzo and ceramic wall tile installation, Glen Canyon Dam and Powerplant.	Dryco, Inc., Downey, Calif.	132,220
500C-302 (SF).	San Juan-Chama, N. Mex.	Dec. 3	Exploratory drilling for ground water investigations.	Water Industries, Inc.	130,700
604C-67	Pick-Sloan Missouri Basin Prog., Mont.	Dec. 3	Removal of gravel and rock fragments from Stilling Basin.	A. H. Powers, Inc., Seattle, Wash.	156,240

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